Reference Points for Cusk (*Brosme brosme*) in NAFO Divisions 4VWX5Z Under the Precautionary Approach Framework

Points de référence pour le brosme (*Brosme brosme*) dans les divisions 4V, 4W, 4X et 5Z de l'Organisation des pêches de l'Atlantique Nord-Ouest en vertu du cadre de l'approche de précaution

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ABSTRACT

Commercial fishery catch rates for cusk have declined since the 1980s. Management measures may have contributed to the reduction in catch rates; however it is thought the decline in catch per unit effort (CPUE) is also due to a decline in cusk abundance. Presently, there are no surveys dedicated to sampling cusk to estimate abundance or biomass. The commercial CPUE trend data based on landings by longliners catching groundfish were used as an index of biomass for developing reference points under the precautionary approach for cusk in NAFO Divisions 4VWX5Z. The average of the commercial CPUE from the period of higher catch rates (1986-1992) was used as a proxy for Maximum Sustainable Yield (MSY). The LRP and USR were calculated as 40% and 80%, respectively, of this MSY proxy. The commercial CPUE data were scaled to the Halibut Industry survey so that the reference points can be established relative to this on-going series. The proposed USR and LRP are 26.6 kg/1000 hooks and 13.3 kg/1000 hooks, respectively. The Halibut Industry survey provides an ongoing time series to be used for monitoring stock status. The 3-year mean CPUE from the Halibut Industry Survey is 18.2, which suggests that the stock is in the cautious zone.

RÉSUMÉ

Les taux de prises de la pêche commerciale pour le brosme ont baissé depuis les années 1980. Les mesures de gestion peuvent avoir contribué à la réduction des taux de prise. Cependant, on pense que la baisse des captures par unité d'effort (CPUE) est également due à la baisse de l'abondance du brosme. Actuellement, il n'y a aucun relevé concernant l'échantillonnage du brosme pour en estimer l'abondance ou la biomasse. Les données sur les tendances des captures par unité d'effort commerciales fondées sur les débarquements par les palangriers capturant des poissons de fond ont été utilisées comme indice de biomasse pour l'élaboration de points de référence en vertu de l'approche de précaution pour le brosme dans les divisions 4V, 4W, 4 X et 5Z. La moyenne des captures par unité d'effort pendant la période où les taux de captures sont plus élevés (de 1986 à 1992) a été utilisée comme indicateur de la production maximale soutenable (PMS). Le point de référence limite et le point de référence supérieur ont été calculés à 40 % et à 80 % respectivement, pour cet indicateur de la production maximale soutenable. Les données sur les captures par unité d'effort ont été proportionnées au relevé de l'industrie du flétan pour que les points de référence puissent être établis en fonction de la série continue. Le point de référence limite et le point de référence supérieur proposés s'élèvent à 26,6 kg/1 000 crochets et à 13,3 kg/1 000 crochets, respectivement. Le relevé de l'industrie du flétan offre une série chronologique continue qui doit être utilisée pour surveiller l'état du stock. La moyenne des captures par unité d'effort sur trois ans du relevé de l'industrie du flétan est de 18,2, ce qui laisse entendre que le stock se trouve dans la zone de prudence.

INTRODUCTION

Commercial fishery catch rates for cusk have declined since the 1980s. Management measures (e.g., trip limits, overall caps, and bycatch percentages) may have contributed to the reduction in catch rates (and landings); however, it is thought the decline in catch per unit effort (CPUE) is also due to a decline in cusk abundance. The extent of the decline in abundance is not known (Harris and Hanke 2010). In February 2012, Fisheries and Oceans Canada (DFO) held a Regional Peer Review meeting to review proposed reference points for a number of stocks, including 4VWX5Z cusk, in the Maritimes region.

Under the precautionary approach framework, the stock status zones are created by defining the Limit Reference Point (LRP) at the Critical:Cautious zone boundary, and an Upper Stock Reference Point (USR) at the Cautious:Healthy zone boundary (DFO 2006). It is preferred to establish reference points and harvest rules based on the best information available on stock biology and fishery characteristics. When there is insufficient information to determine stock biomass, as for cusk, DFO has provided guidelines for identifying proxies, which can be used for defining precautionary approach reference points. Default reference points based on biomass indices are defined as:

"In critical zone".
The stock is considered to be in "the critical zone" if the mature biomass, or its index, is less than or equal to 40% of B_{MSY}. In other words: *Biomass ≤ 40% B_{MSY}*.

"In cautious zone".
The stock is considered to be in the "cautious zone" if the biomass, or its index, is higher than 40% of B_{MSY} but lower than 80% of B_{MSY}. In other words: *40% B_{MSY} < Biomass < 80% B_{MSY}*.

"Healthy".
The stock is considered to be "healthy" if the biomass, or its index, is higher than 80% of B_{MSY}. In other words: *Biomass ≥ 80% B_{MSY}*. (DFO 2009)

These definitions were used as guidance in the development of the proposed reference points for cusk.

METHODS

DATA SOURCES

There are no surveys dedicated to sampling cusk. The Maritimes region Ecosystem Survey is not thought to be proportional to cusk total population abundance because it does not sample the preferred habitat or depths of cusk (DFO 2008).

Halibut Industry Survey Data

The Halibut Industry Survey is a longline survey that samples an area from the Grand Banks of Newfoundland, along the Scotian Shelf to Georges Bank. Longline gear is an effective sampling tool for cusk as demonstrated by the commercial fishery; over 90% of landings were made by the longline fleet (Harris and Hanke 2010). This survey began in 1998; however, the data from 1998 were excluded due to a lesser number of sets in that year. Though it is a fixed-

station design, not all stations are sampled in all years. Only fixed stations that were sampled in all years were included (n=57). This portion of the survey includes some of cusk's preferred habitat including deeper areas along the shelf edge (Figure 1), although only a few of these stations were in the Gulf of Maine, the area of highest commercial landings (Figure 2). Despite some concerns over the consistency of protocols (e.g., bait type, stations sampled), the Halibut Industry Survey is considered to be proportional to total population biomass (DFO 2008). The catches per set, the highest of which is over 900 kg, were used to calculate standard catch per unit effort in kilograms per 1000 hooks. Where stations had multiple sampling trips within the same calendar year, the average CPUE for the year was taken for that station.

Commercial Fishing Data

Reported cusk landings (Figure 3) have been used to examine CPUE trends over the long term (Harris and Hanke 2010) since there are no reliable long-term survey data. The reliability of the landings data has been questioned anecdotally, particularly those data collected before 1999 when the bycatch cap was implemented. Previously there was no catch limit for cusk. It has been suggested that other species, such as cod, were landed as cusk when the target species quotas were exceeded. This would have artificially raised estimates for historical landings and catch per unit effort of cusk, and exaggerated the decline in catches.

The CPUE trend is based on landings by longliners catching groundfish since this sector has the highest cusk landings (Harris and Hanke 2010). Most landings of cusk are from waters off of southwestern Nova Scotia; therefore, landings from unit areas 4Xnopqu (Figure 4) were included in the analysis. Areas of marginal cusk habitat (sandy or muddy bottoms) and low cusk catches, such as the Bay of Fundy, were not included. Trips were used as the measure of effort. The number of days at sea is not available for 1994 and was sporadically recorded prior to that year, making trip the only reliable metric of effort (Gavaris 1996). Analysis was derived from tonnage class 2 and 3 vessels (25-149.9 gross registered tonnes); no effort information is available for small longliners (gross registered tonnage <24.9) before 1997. Often in the earlier years, the commercial vessel number for small longliners was not recorded and landings from several vessels and/or trips were aggregated (Gavaris 1996).

The analysis of CPUE began with the start of the zonal interchange format (ZIF) time series in 1986. The quota year changed in 1999. Prior to 1999, the quota year was the same as the calendar year. In 1999, the quota year ran from January 1999 to March 31, 2000. In 2000, and subsequently, quota years ran from April 1st to March 31st. CPUE trends are influenced by management measures. In 2003 and 2007, cusk landings were high during the first half of the fishing year. In an effort to keep landings from further surpassing the bycatch cap of 750t, cusk closures were implemented for longliners in vessel classes less than 65 feet starting in December in 2003 to the end of the quota year and at the end of September in 2007 to the end of the quota year for vessels less than 45 feet. CPUE was calculated only for the July to September period for all years in order to have a consistent index over time. It is in these months that most cusk are landed. Only using data from these months for analyses also removes any influence of changes in fishing year on CPUE.

ANALYSIS

There are no estimates of cusk abundance or biomass. It is generally accepted that the abundance of cusk has declined since the 1980s (Harris and Hanke 2010, Figure 3). There are indices available which can be used to determine biomass trends for cusk, however, there is no single index that covers a long enough time-series.

The Halibut Industry Survey is considered to provide useful information on trends in cusk abundance in NAFO Divisions 4VWX5Z since 1999. It can provide information on whether there is an increasing or decreasing trend in abundance in the current time period. It does not provide any information from before the decline and so it cannot be used to calculate a reference point against which this trend can be compared to determine stock status.

The commercial CPUE includes the period of higher cusk abundance; however, an update of this series to present day was not considered appropriate due to changes in management measures since the 2007 Recovery Potential Assessment (RPA) for cusk. It was decided that the commercial CPUE trend from the RPA would be used for reference to provide an accepted biomass trend in the historic period to calculate proposed LRP and USR and the Halibut Industry Survey would be used to monitor stock status.

The commercial landings CPUE began to decline in 1993. The average of the CPUE from the period of higher rates (1986-1992) was used as a proxy for Maximum Sustainable Yield (MSY). The LRP and URP were calculated as 40% and 80%, respectively, of this MSY proxy. The commercial CPUE data were scaled to the Halibut Industry Survey so that the reference points can be established relative to this on-going series. The scaling factor was calculated for the time period where the two time series overlap (1999-2007). The Halibut Industry Survey could then be used to determine the status of cusk relative to these scaled reference points.

RESULTS

The proposed USR and LRP for cusk in NAFO Divisions 4VWX5Z are 26.6 kg/1000 hooks and 13.3 kg/1000 hooks, respectively (Figure 5). The recent trend in the Halibut Industry Survey (3-year running geometric mean) would be used to determine the status of the cusk biomass in relation to the reference points. An average over several years is proposed for ongoing monitoring of stock status due to variability in the survey data. The geometric mean is suggested in preference to the arithmetic mean because it dampens the impact of occasional very high sample points on the average, providing slightly enhanced stability. The mean CPUE from the Halibut Industry Survey has been at or above the proposed LRP for the last 3 years (Table 1) although a high level of uncertainty is indicated by the wide confidence interval (Figure 5). The geometric mean of the CPUE for 2009-2011 is 18.2 kg/1000 hooks, which suggests that the stock is in the cautious zone (Figure 5).

There are other factors that contribute to the uncertainty in trends in biomass for cusk which cannot be quantified. Sources of uncertainty in the catch-rate trends include the reliability of commercial fishing data, and the effects of factors other than abundance on commercial catch rates (e.g., management measures, socio-economic factors, fish behaviour). The lack of consistent sampling in areas of highest cusk density by the Halibut Industry Survey is a source of uncertainty in relation to our ability to accurately monitor trends in cusk abundance on an ongoing basis.

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Table 1. *Average catch per unit effort (kg/1000 hooks) for stations sampled in all years in the Halibut Industry Survey.*

Year	CPUE
1999	16.8
2000	19.1
2001	13.8
2002	11.8
2003	12.5
2004	15.1
2005	11.4
2006	7.3
2007	18.4
2008	17.8
2009	13.9
2010	19.0
2011	22.8

Figure 1. *Distribution and magnitude of the average catch of cusk in the Halibut Industry survey from 1999-2011 in kg/1000 hooks. Only stations that were sampled in all years were included (n=57). The red line represents the Exclusive Economic Zone.*
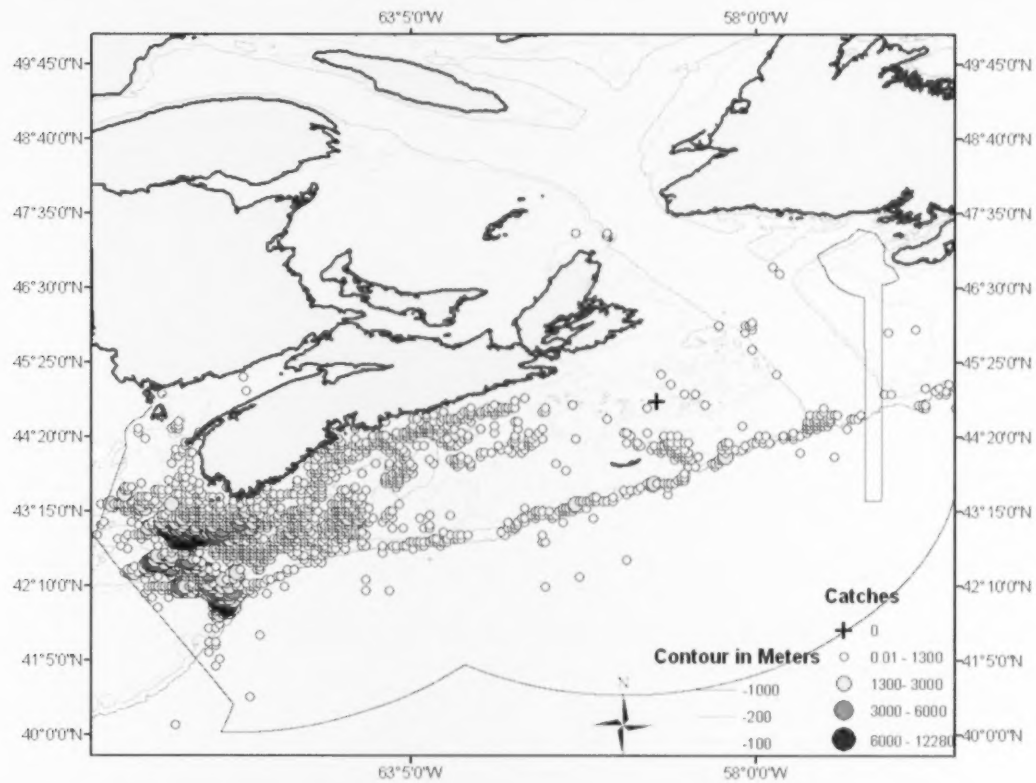
Figure 2. Magnitude and distribution of cusk catches by longliners in 2010-2011 in metric tonnes, summed by 5 minute squares. The red line represents the Exclusive Economic Zone.
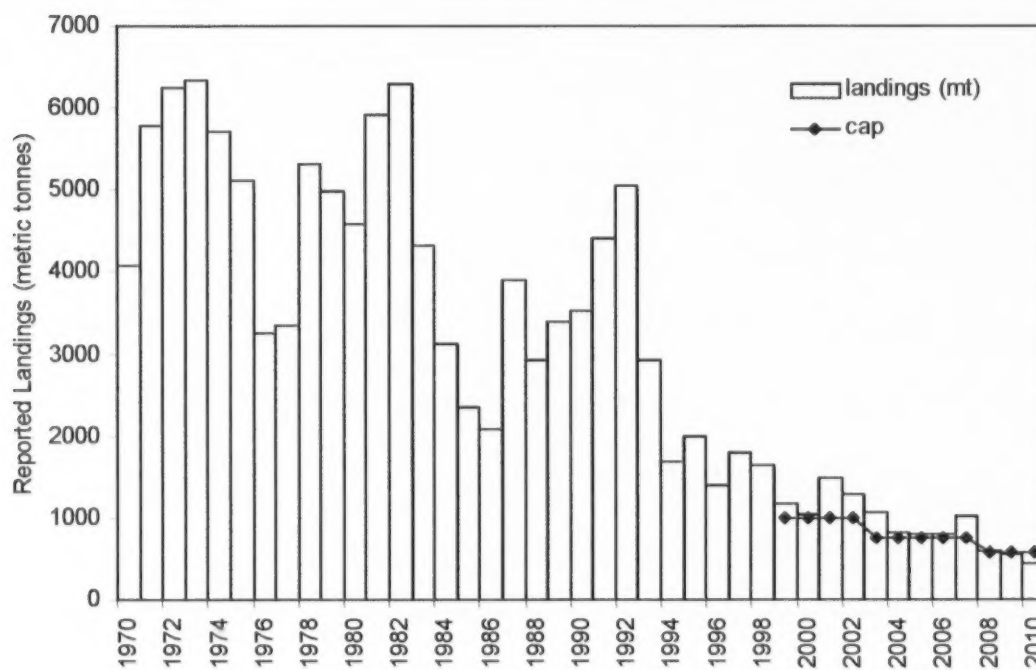
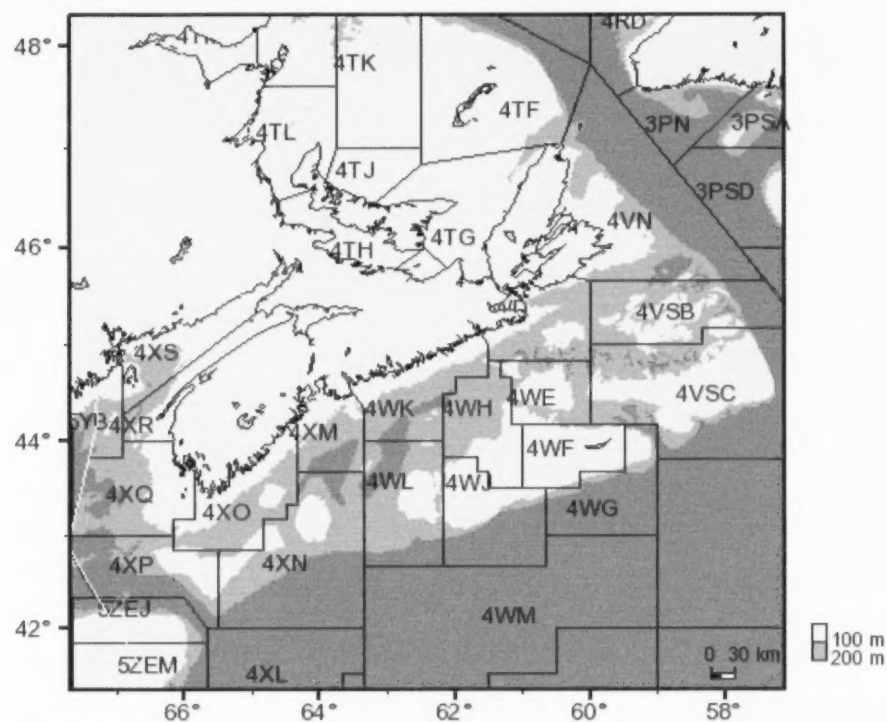Figure 3. *Reported landings for cusk for all gear types in 4VWX5Z. Blue line indicates the bycatch cap.*

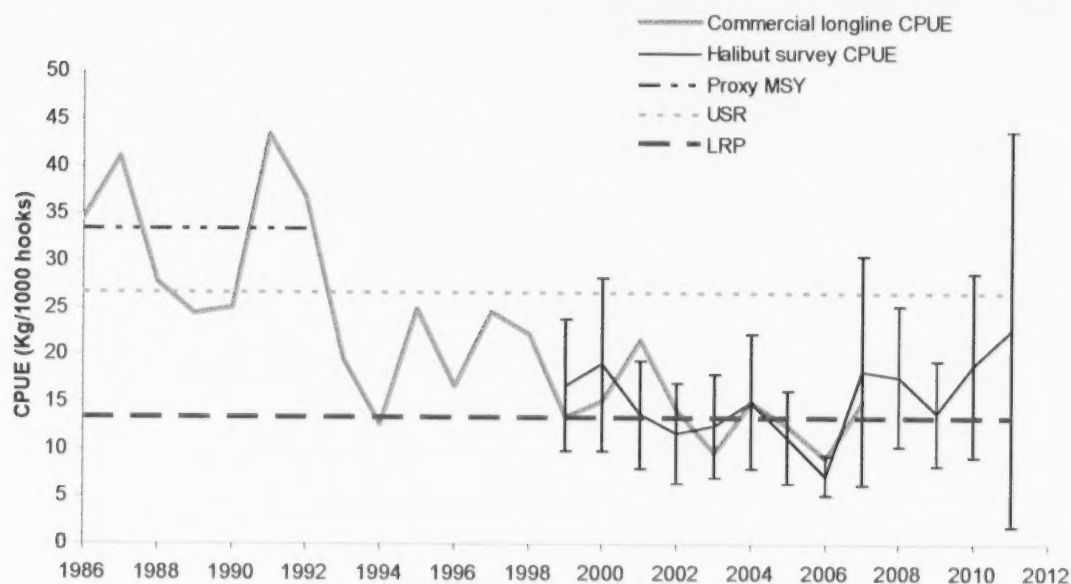*Figure 4. Location of statistical unit areas mentioned in the text.*

Figure 5. *The blue reference line represents the MSY proxy, the grey line represents the trend in commercial longline CPUE (scaled to the Halibut Industry Survey), the green reference line represents the upper stock reference point (80% of MSY proxy), the red reference line represents the limit reference point (40% of MSY proxy), the black line represents the Halibut Industry Survey CPUE (kg/1000 hooks) for stations sampled in all years (n=57) including the 95% confidence interval.*